Logistics Management Institute

Metrics for the Apparel Research Network

Volume II: Financial Analysis of the Research Program

DL702T2

August 1997

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LMI®

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Executive Summary

The Apparel Research Network (ARN) is a consortium, formed in 1994 by the Defense Logistics Agency (DLA), whose purpose is to improve the design, production, and distribution of defense clothing. The ARN comprises 22 universities, technology companies, consultants, and manufacturers. ARN work is performed under R&D contracts awarded by DLA. Representatives from government clothing operations guide the research and manage its implementation. DLA engaged the Logistics Management Institute (LMI) to conduct a financial analysis of the ARN R&D program.

The R&D contemplated by the ARN would benefit both the defense clothing industrial base and the government's clothing operations. The defense clothing industrial base includes not only apparel manufacturers, but also supporting industries, such as sundry item (e.g., button) producers, equipment makers, and textile mills. Government clothing operations include garment design, test, procurement, and distribution.

DLA's budget for the ARN is $31 million, allocated from FY94 to FY01. As of 30 Sep 1996 (the end of FY96), DLA had budgeted $16 million but had committed only $13.8 million of that amount. For purposes of this financial analysis, LMI assumed that DLA will incur its budgeted cost profile.

Offsetting the costs incurred by DLA for ARN research are benefits accruing to defense manufacturers, the Defense Personnel Support Center, and the military services. At the direction of DLA, we use a 9-year planning horizon. Most benefits are expressed as annual cash flow savings, so they in fact will continue to accrue beyond that horizon.

ARN R&D projects are grouped into five topic areas. The following list briefly describes these areas and the benefits each will provide:

- *Measurement and Pattern Generation I.* This area will streamline and automate the information flow associated with special measurement orders. It will reduce fit test costs and special measurement order costs.

- *Measurement and Pattern Generation II.* This area will implement automated, three-dimensional body scans for military recruit measurement and uniform sizing. It will eliminate the need for anthropometric surveys and reduce the number of uniform alterations and the time recruits spend in uniform issue.

- *Hardware, Automation, and Control.* This area will automate small parts sewing at apparel manufacturers and increase sewing machine operator productivity.

- *Systems Integration.* This area will streamline and automate the flow of information between defense apparel firms and the government and improve the flow of materials and information at apparel manufacturers. It will reduce manufacturers' and wholesale inventories and manufacturers' labor costs.

- *Ordering and Distribution.* This area will improve retail inventory management and coordinate the flow of material from manufacturing, through wholesale, to retail. It will reduce wholesale and retail inventories and will prevent manufacturers' inventories from growing to compensate.

The benefits resulting from the ARN include cost avoidance. A cost avoidance reflects money not spent that otherwise would have been, or money freed up and used for some other purpose. For example, the ARN's largest single benefit will be the reduction of Army recruit measurement time. This benefit is a cost avoidance because the Army will probably choose to increase its recruits' drill time rather than reducing its recruit payroll. Our analysis, then, measures the overall attractiveness of the ARN but does not necessarily predict the changes that will take place on any given organization's financial statements.

The total of then-year benefits expected from the ARN through FY02 is $53.24 million. To account for the different timing of costs and benefits, as well as for the time value of money, we computed the net present value. We used a discount rate of 6 percent, as directed by DLA policy and the Office of Management and Budget. The net present value over the 9-year horizon is $10.1 million. Using the discounted flows, the program will pay back (i.e., break even) in FY02.

We also examined the sensitivity of the net present value to changes in costs and benefits, the discount rate, and the planning horizon. If the remaining ARN costs

($3 million per year from FY98 to FY01) were to double, the net present value of the ARN would be negative $1.82 million. In that case, however, the net present value would turn positive if the horizon were extended 1 year to FY03.

If the expected benefits of the ARN fail to fully materialize, the net present value will decrease. The net present value will be zero (over the nominal 9-year horizon) if benefits fall to 74 percent of their projected value.

Larger discount rates would lower the impact of ARN future savings. While the ARN's net present value is sensitive to changes in the discount rate, that rate would have to increase to approximately 14 percent to drive the net present value to zero (resulting in no net benefits to DoD). Longer planning horizons increase the net present value. For example, an infinite horizon would yield a net present value of approximately $168 million.

From a financial perspective, therefore, the ARN program appears to be an attractive investment. If the program is executed as planned, the expected net present value is $10.1 million; a positive payback will be realized even if costs almost double or if benefits fall short of expectations by one-quarter.

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Preface

The Defense Logistics Agency (DLA) engaged the Logistics Management Institute (LMI) to quantitatively describe the defense clothing business, to assist the Apparel Research Network (ARN) researchers in evaluating the costs and benefits of their individual projects, and to perform an overall financial analysis of the ARN program. We were asked to describe the defense clothing business because there is no single organization that manages or oversees all the activities and costs involved; therefore, no one entity could provide an overall description. The total picture involves hundreds of private-sector suppliers, DLA, and the military services.

This report comprises two volumes. In Volume I, we provide a summary description of the defense apparel production and distribution business. The bulk of that volume provides cost, lead-time, and quality measures for key aspects of the business. These measures are useful for identifying research targets of opportunity and for evaluating the potential and progress of ARN projects.

In Volume II, we present an overall financial analysis for the ARN, computing net cash flows and net present values of all the projects combined. That analysis involves more than a simple tabulation of individual project costs and benefits, because some ARN program "overhead" costs need to be allocated (i.e., charged against benefits) and some duplication of benefits across projects necessitates an adjustment to the research projections.

Taken together, the two volumes present a consolidated profile of defense apparel business, describe the research program being contemplated to improve that business, and evaluate the net benefits to the government for its support of that research.

Chapter 1
Background and Financial Summary

BACKGROUND

The ARN is a consortium, formed in 1994, with the aim of improving the design, production, and distribution of defense clothing. The ARN's scope includes all aspects of the apparel life cycle, from concept through manufacturing to issue to members of the military. ARN research seeks to reduce cost, shorten response times, and improve the quality of defense clothing. Potential technical areas include materials, computer-aided design, sewing technology, electronic data interchange, computer-integrated manufacturing, production control, work methods, equipment development and automation, and quality assurance techniques.

The R&D contemplated by the ARN would benefit both the defense clothing industrial base and government clothing operations. The defense clothing industrial base includes not only apparel manufacturers, but also supporting industries, such as sundry item (e.g., button) producers, equipment makers, and textile mills. Government clothing operations include garment design, test, procurement, and distribution.

DLA's Manufacturing Science and Technology Program funds and administers the ARN. The ARN membership consists of "partners," who perform research, and representatives from government clothing operations, who help guide the research and manage its implementation. As shown in Table 1-1, the ARN partners include universities, industrial consultants, equipment and software companies, and an apparel manufacturer.

Additional apparel manufacturers are participating informally. The government representatives working with the ARN include representatives from DLA's Defense Personnel Support Center (DPSC) and the military service clothing design and distribution operations.

The ARN represents a novel approach to government R&D. Traditionally, R&D is organized in one of two ways. In one way, the government defines the research it wants done and then solicits proposals. In the second way, individual researchers develop ideas and sell them to the government via unsolicited proposals. Under the ARN, DLA first pays the partners "seed money" to collectively define the research agenda and then solicits R&D proposals from individual partners or teams of partners. The key differences are that both the researchers and the government participate in R&D planning, and that researchers from different organizations collaborate to a much greater degree. The result is a research agenda that more

Table 1-1. ARN Partners

Anthropology Research Project	The HAAS Tailoring Company
Auburn University	Jet Sew Technologies
Beecher Research Company	National Institute of Standards and Technology
California State Polytechnic University, Pomona	North Carolina State University
Charles Gilbert Associates	Ohio University
Clarity Fit Technologies	Philadelphia College of Textiles and Sciences
Clemson Apparel Research	Rensselaer Polytechnic Institute
Cyberware	Southern Polytechnic State University
EDI Integration Corporation	University of Southwestern Louisiana
Florida International University	University of Wisconsin–Stout
Georgia Institute of Technology	Wizdom Systems

Source: Apparel Research Network World Wide Web site at http://mtiac.hq.iitri.com/arn/, 16 April 1997.

closely matches the needs of the government and that draws on the best capabilities of each of the individual researchers.

The projected duration of the ARN is 7 years (beginning in 1994), including a 3-year base period followed by two 2-year options. The ARN statement of work calls for the ARN partners to work together to identify broad objectives for 3-, 5-, and 7-year time periods. The principal product of initial collaboration is a technical plan identifying opportunities and defining projects for technology improvement through the base contract period and its option periods. The technical plan must describe problems being addressed, the methodology or technical approach to be used, and the anticipated benefits after implementation.

Two demonstration sites augment the ARN research projects. These sites, at California State Polytechnic University, Pomona, and at Clemson Apparel Research, manufacture limited quantities of military garments and assist with the transition of new technology from research to actual operations. The sites also perform education and training and measure the effect of ARN research. Because the demonstration sites perform actual production (their garments are worn by soldiers), and because they must interface with industry suppliers (e.g., for fabric and sundries) and the government (e.g., for orders and billing), they develop a very realistic understanding of the challenges and opportunities in the defense clothing business. Also, because they operate within a university research setting, free from the competitive pressures of dedicated apparel producers, they also enjoy the opportunity to explore and apply novel solutions to the problems they identify.

A government joint planning committee oversees the ARN partners' work and that of the demonstration sites. The committee members provide expertise in related technical areas, help select and prioritize candidate projects, and monitor progress. Table 1-2 lists the organizations supplying committee members.

Table 1-2. Joint Planning Committee Members

Defense Personnel Support Center	U.S. Coast Guard Clothing Activity
U.S. Air Force Clothing Division	Headquarters, U.S. Marine Corps
U.S. Army Natick Research, Development, and Engineering Center	U.S. Navy Clothing and Textile Research Facility
Office of the Deputy Chief of Staff for Logistics	Navy Exchange Service Command

Source: Apparel Research Network World Wide Web site at http://mtiac.hq.iitri.com/arn/, 16 April 1997.

In addition to the committee members, representatives of the military services recruit induction centers (RICs) provide technical assistance to the ARN partners.

The ARN partners have created three "focus groups" to coordinate their efforts. These groups are

- design and development,
- preproduction and production, and
- ordering and distribution.

Design and development activities include garment concept, pattern generation, and testing. Preproduction and production includes production management, marker making, cutting, and sewing at apparel manufacturers. Ordering and distribution includes the storage, transportation, and issuing of clothing at manufacturers, wholesale warehouses, and retail sites. These ARN focus groups foster the cooperative development of project ideas and research proposals. Complementary projects that support, or lead to, the improvement of a specific operation within a focus group are combined to form a "supertask."

At the direction of DLA, the ARN research concentrates on the clothing issued to new recruits at the RICs. Collectively, this clothing is known as "bag items" because of its association with the recruit's duffel bag. Specifically, the ARN is focusing initially on battle dress uniforms (BDUs) and Army men's dress uniforms. BDUs are moderate-cost items with large unit demand; dress uniforms are high-cost items with moderate demand.

FINANCIAL SUMMARY

Costs

DLA's budget for the ARN is $31 million, allocated between FY94 and FY01. Table 1-3 shows the timetable of the anticipated spending.

Table 1-3. DLA Budget for the ARN (millions of dollars)

Year	FY94	FY95	FY96	FY97	FY98	FY99	FY00	FY01	Total
Budget	6	10	0	3	3	3	3	3	31

As of 30 Sep 1996 (the end of FY96), DLA had committed $13.8 million. Table 1-4 lists these commitments, which include contract awards as well as contracts in process.

Table 1-4. DLA Funding Commitments Through 30 Sep 1996

Category	Funding committed (millions of dollars)
Member collaboration	1.4
Demonstration sites	6.0
Research contracts	4.1
Approved research concepts	2.3
Total	13.8

Member collaboration totals $1.35 million and includes $900,000 "seed money" for cooperative research proposal development and $450,000 for focus group coordination. That coordination involves reconciling individual research proposals so that an overall, joint objective is met within the design, production, and distribution focus groups.

The ARN demonstration sites, as mentioned previously, are at California State Polytechnic University, Pomona, and at Clemson Apparel Research. The $6.0 million funding figure represents an annual level of $1.0 million at each site for FY95, FY96, and FY97.

As of 30 Sep 1996, DLA had awarded $4.1 million in research contracts and had approved in concept an additional $2.3 million. Collectively, this $6.4 million corresponds to the funding cited in business cases prepared by each focus group. This figure is important because it is the level of research funding upon which the ARN benefits are based (i.e., if the ARN were to perform less research, the benefits would have to be scaled back accordingly).

At the time of this writing, therefore, DLA's expenditures for the ARN are running below budget by $1.2 million ($16 million was budgeted through FY96 and $13.8 million has been committed). For purposes of the financial analysis, however, we assume that DLA will incur the cost profile it has budgeted.

Benefits

Offsetting the costs incurred by DLA for ARN research are benefits accruing to defense manufacturers, the DPSC, and the military services. Based on guidance from DLA, we have assumed a 9-year planning horizon. Most benefits are expressed as annual cash flow savings, so they in fact will continue to accrue beyond that horizon.

ARN R&D projects are grouped into five topic areas called supertasks. The research program, costs, and benefits of each supertask are described in Chapters 2 through 4. The following list briefly describes these supertasks and the benefits each will provide:

- *Measurement and Pattern Generation I.* This supertask will streamline and automate the information flow associated with special measurement orders. It will reduce fit test costs and special measurement order costs.

- *Measurement and Pattern Generation II.* This supertask will implement automated, three-dimensional body scans for military recruit measurement and uniform sizing. It will eliminate the need for anthropometric surveys and reduce the number of uniform alterations and the time recruits spend in uniform issue.

- *Hardware, Automation, and Control.* This supertask will automate small parts sewing at apparel manufacturers and increase sewing machine operator productivity.

- *Systems Integration.* This supertask will streamline and automate the flow of information between defense apparel firms and the government, and improve the flow of materials and information at apparel manufacturers. It will reduce manufacturers' and wholesale inventories and manufacturers' labor costs.

- *Ordering and Distribution.* This supertask will improve retail inventory management and coordinate the flow of material from manufacturing, through wholesale, to retail. It will reduce wholesale and retail inventories and will prevent manufacturers' inventories from growing to compensate.

Table 1-5 summarizes the cash flow savings from each of these supertasks. These cash flows are based on business cases prepared by the ARN researchers, but in some cases were adjusted by LMI to reflect changes in business parameters (e.g.,

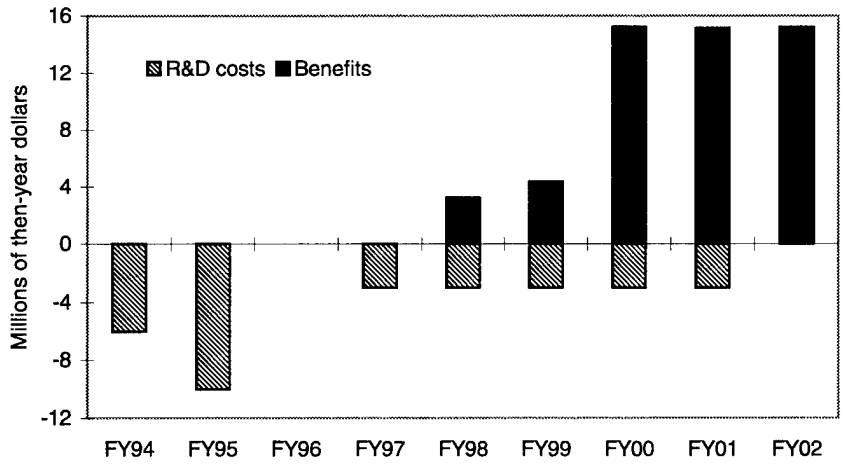
inventory holding rates) or to eliminate duplicate savings across projects. Volume I discusses the various parametric values that helped define the business cases. Because not all contract awards have been made, the starting date of benefits may be delayed. Unless we had specific information to the contrary, we assumed that all projects will be under way and begin showing savings in FY98.

Table 1-5. Summary of Benefits (millions of then-year dollars)

Supertask	FY98	FY99	FY00	FY01	FY02
Measurement and Pattern Generation I	1.72	1.72	1.54	1.54	1.54
Measurement and Pattern Generation II	0.20	0.20	10.43	10.43	10.43
Hardware, Automation, and Control		0.15	0.20	0.26	0.29
Systems Integration	0.49	0.81	1.16	1.01	1.04
Ordering and Distribution	0.85	1.50	1.91	1.91	1.91
Total	3.26	4.38	15.24	15.15	15.21

The total of then-year benefits expected from the ARN through FY02 is $53.24 million. Figure 1-1 shows then-year cash flows for both ARN costs and benefits.

Figure 1-1. ARN Costs and Benefits



The benefits resulting from the ARN represent a mix of "accountable" savings and cost avoidance savings. Accountable savings are those that can be traced to an organization's income statement, balance sheet, or other recognized financial statement. Cost avoidance savings reflect money not spent that otherwise would have been, or money freed up and used for some other purpose. For example, the largest single savings projected by the ARN researchers is the reduction of Army recruit measurement time in supertask Measurement and Pattern Generation II.

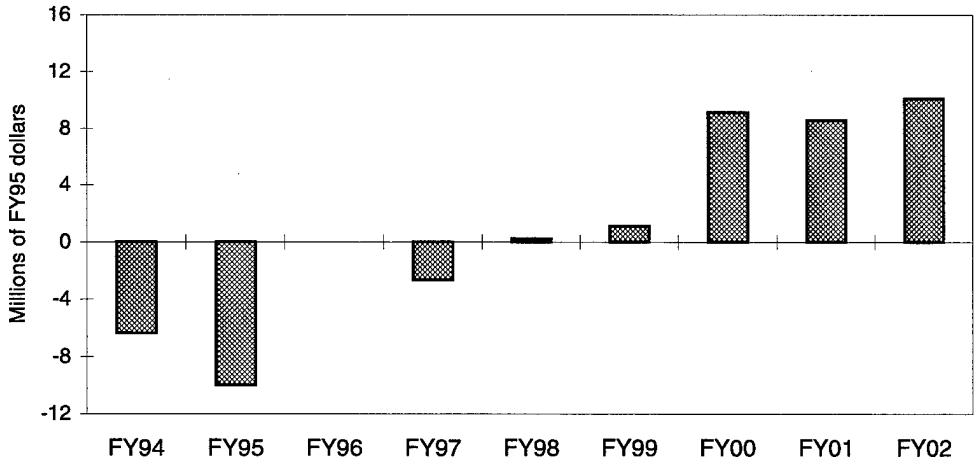
This savings is a cost avoidance, because the Army will probably choose to increase its recruits' drill time rather than reducing its recruit payroll. In that case, the recruit time freed up by the ARN research will be used for another purpose.

Also, because the ARN's costs and benefits will accrue to a number of organizations, both public and private, some organizations may experience a net financial loss while others experience a net financial gain. The results we present represent the ARN's potential impact on the overall defense apparel production and distribution system. Except for the example above, we do not attempt to distinguish between accountable savings and cost avoidance savings, and we do not attempt to identify which organizations will be net gainers and which will not. Our analysis, then, measures the overall attractiveness of the ARN but does not necessarily predict the changes that will take place on any given organization's financial statements.

Net Present Value

We express the net present value of the ARN in FY95 dollars. We used a discount rate of 6 percent, as directed by DLA policy and the Office of Management and Budget.[1] Figure 1-2 shows the net cash flow expressed in constant FY95 dollars. The net present value over the 9-year horizon is $10.1 million. Using the discounted flows, the program will pay back (i.e., break even) in FY02.

Figure 1-2. ARN Discounted Cash Flow (FY95 dollars)



[1] See DoD Instruction 7041.3, *Economic Analysis for Decisionmaking*, 7 Nov 1995. We obtained the current discount rate, valid through February 1998, from Office of Management and Budget Circular A-94, *Discount Rates for Cost Effectiveness, Lease Purchase, and Related Analyses*, posted on the World Wide Web at http://www1.whitehouse.gov/wh/eop/omb/html/circulars/a094.html#ap-c.

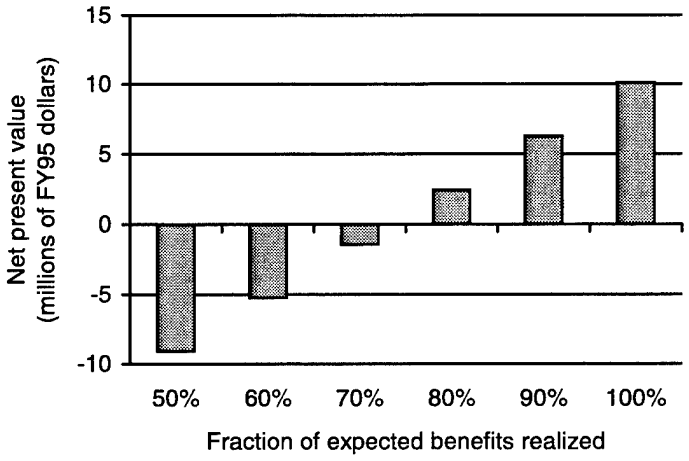
Sensitivity Analyses

In this section we explore how changes to expected costs and savings, the discount rate, and the given planning horizon would affect the net present value of the ARN. Because the ARN nominally has a positive net present value, we only consider changes that might lower that value (i.e., delay payback).

ARN research costs through FY96 have already been incurred. If the remaining costs ($3 million per year from FY98 to FY01) were to double, the net present value of the ARN would be negative $1.82 million. In that case, however, the net present value would turn positive if the horizon were extended 1 year to FY03.

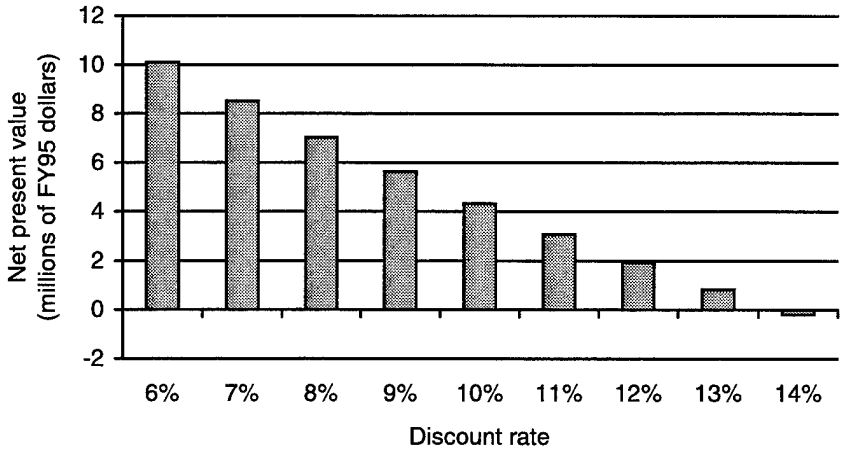
If the expected benefits of the ARN fail to fully materialize, the net present value will decrease. Figure 1-3 shows that the net present value will be zero (over the nominal 9-year horizon) if benefits fall to 74 percent of their expected value.

Figure 1-3. Sensitivity of ARN Net Present Value to Expected Benefits Not Realized



Larger discount rates would lower the impact of ARN future savings. While the ARN's net present value is sensitive to changes in the discount rate, that rate would have to increase to approximately 14 percent to drive the net present value negative. Figure 1-4 shows the effect of discount rates on net present value.

Figure 1-4. Sensitivity of ARN Net Present Value to the Discount Rate



As discussed above, DLA directed that we use a 9-year planning horizon that runs between FY94 and FY02. Because ARN funding, and the associated R&D, runs through FY01, we do not consider the effects of shortening the planning horizon. If the planning horizon were to be extended, the net benefits of the ARN would increase. Each year of additional horizon adds approximately $15 million in benefits, which must then be discounted to FY95 dollars. If an infinite horizon were considered, the net present value of the ARN would be approximately $168 million.[2]

In the remainder of Volume II, we provide project descriptions and expected costs and benefits. Chapter 2 contains information on the two supertasks covered by the ARN's design and development focus group: Measurement and Pattern Generation I and II. In Chapter 3 we present the two supertasks managed by the ARN's preproduction and production focus group: Hardware, Automation, and Control, and Systems Integration. Finally, in Chapter 4, we discuss the Ordering and Distribution supertask.

[2] To derive this figure, we first calculate the FY03 value of $15 million per year in perpetuity. At a 6 percent discount rate, that value is $15 million divided by 0.06 or $250 million. We then discount that value to FY95 dollars using the factor 0.63. The result is $158 million. Adding that figure to the nominal ARN net present value of $10 million gives $168 million.

Chapter 2
Design and Development

The design and development focus group has organized its research into two supertasks, each of which is a collection of individual projects. The design and development supertasks are named Measurement and Pattern Generation I and II.

MEASUREMENT AND PATTERN GENERATION I

Description

The design and development focus group has proposed four projects to streamline and automate the information flow associated with special measurement orders and to lay the groundwork for replacing hand measurements with three-dimensional body scanning. Collectively, the ARN refers to these projects as a supertask called Measurement and Pattern Generation I.

Today, special measurement uniform orders are posted manually at the order point and sent by fax or mail to DPSC. Although DPSC stores the Army men's dress uniform patterns electronically, it still handles all special measurement orders manually. Most government contractors responsible for manufacturing special measurement uniforms also handle the tracking, invoicing, and shipping of these orders manually. These projects seek to automate as much of this process as possible by using current computer technology. Automation would improve the accuracy of order data, eliminate duplication of effort, and speed up the processing time.

In addition to automating the special measurement order process, the projects also address the conversion of anthropometric data into information on which sizes and alterations can be based. A brief description of the project plan illustrates how this will be accomplished. First, the researchers will develop methods that will allow military clothing designers to convert relevant dimensional data from existing anthropometric databases into patterns, just as they would if they had gotten the data through measurements using traditional tailor methods. Second, the researchers will develop standardized measurement procedures for a set of key garment dimensions. These procedures would then be used in future large-scale anthropometric surveys as well as by those preparing special measurement forms, so that appropriate dimensions will be available to designers without the need for conversion equations. When the ability to gather three-dimensional data from whole body scanning is in place, it will be possible to take anthropometric measurements from the body images, and those measurements can then be immediately used to convert anthropologist-style dimensions into tailor-style dimensions. This

will be necessary because three-dimensional scanning will be done with the subject partially nude so the traditional tailoring landmarks and alteration points will be missing.

Research Costs and Expected Benefits

The total projected research cost for these projects is $1,160,907, of which $1,122,685 had been awarded as of 30 Sep 1996.

The anthropometric data resulting from this research will reduce—by $1,363,680 per year—the costs of field testing new garment designs for proper fit. The cost of processing the current volume of special measurement orders will be reduced by an average of $360,790 per year until a reduction in the number of special measurements (due to other ARN projects) cuts the expected annual savings to $180,395 beginning in the year 2000. Table 2-1 summarizes these expected benefits.

Table 2-1. Expected Benefits of Measurement and Pattern Generation I

Benefit	Savings
Reduced fit testing cost	
15 fit tests per year eliminated at $90,912 per test	Savings of $1.36 million per year
Reduced special measurement order cost	
Special measurement order process time reduced by 53 percent	Savings of $360,790 per year (FY98 to FY99)[a]

[a] We reduced the annual savings by 50 percent to $180,395 for FY00 and beyond to reflect the 50 percent reduction in special measurement activity.

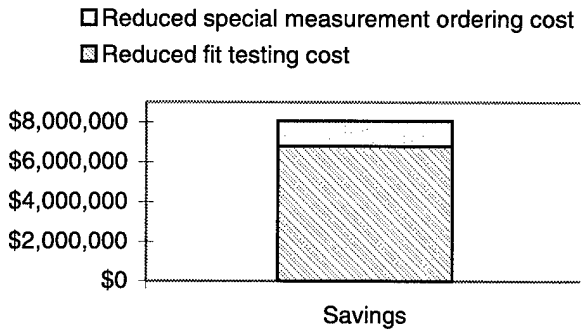
Table 2-2 shows the savings per fiscal year in the costs of field testing new garment designs and processing special measurement orders.

Table 2-2. Timing of Measurement and Pattern Generation I Savings (millions of then-year dollars)

Benefit	FY98	FY99	FY00	FY01	FY02
Reduced fit testing cost	1.36	1.36	1.36	1.36	1.36
Reduced special measurement order cost	0.36	0.36	0.18	0.18	0.18
Total	1.72	1.72	1.54	1.54	1.54

Figure 2-1 illustrates the expected savings from this supertask through FY02.

Figure 2-1. Expected Benefits from Measurement and Pattern Generation I



MEASUREMENT AND PATTERN GENERATION II

Description

The supertask called Measurement and Pattern Generation II complements the Measurement and Pattern Generation I supertask to reach the ultimate goal of using automated three-dimensional body scans for recruit measurement. This supertask contains three projects to develop the tools required to use the output of full-body scanners for anthropometric data collection and analysis, custom and standard pattern specification, and size prediction. The desired outcome is an accurate data set for each person, reflecting the true three-dimensional geometry of the body, with no extraneous points. With these data, custom uniforms can be manufactured on demand with a minimum of alterations.

Research Costs and Expected Benefits

The total projected research cost for these projects is $3,061,700, of which $1,871,604 had been awarded as of 30 Sep 1996.

The technology resulting from these projects will enhance DLA's current efforts to reduce inventory and logistics response time. The benefits will include the following:

- The periodic need for anthropometric surveys will be eliminated.
- The number of size revisions will be reduced, and revisions will be automated.
- The time spent by Army recruits in uniform issue will be reduced.

- Ninety percent of Army recruit alterations will be eliminated.
- The number of Army recruit special measurements will be reduced.

Table 2-3 shows the costs and savings associated with these benefits.

Table 2-3. Expected Benefits of Measurement and Pattern Generation II

Benefit/cost item	Savings/costs
Elimination of anthropometric surveys	
Savings of $2 million every 20 years.	Savings of $100,000 per year
Automation of size revisions	
Savings of $2 million every 20 years.	Savings of $100,000 per year
Reduction in Army RIC cost and recruit training cost	
Number of Army RIC issue personnel reduced by 12.	Savings of $990,000 per year
Recruit time in clothing issue reduced by 4 hours.	Savings of $7 million per year
Six scanners at $410,000 apiece, amortized over 10 years at 6.1 percent.	Cost of $336,000 per year for 10 years
Recruits scanned at $10 each for 120,000 recruits.	Cost of $1.2 million per year
Reduction in alteration cost	
90 percent of current $3.5 million in alteration cost eliminated ($29 per recruit, 120,000 recruits).	Savings of $3.15 million per year
Reduction in special measurement pattern cost	
Number of special measurements reduced from 2,400 per year to 1,200 per year. Special measurement pattern cost reduced from $525 to $350 (1,200 former special measurements used standard $175 pattern).	Savings of $630,000 per year

Table 2-4 shows the savings per fiscal year in the areas of anthropometric surveys, size revisions, recruit training time, alterations, and special measurements.

Table 2-4. Timing of Measurement and Pattern Generation II Savings (millions of then-year dollars)

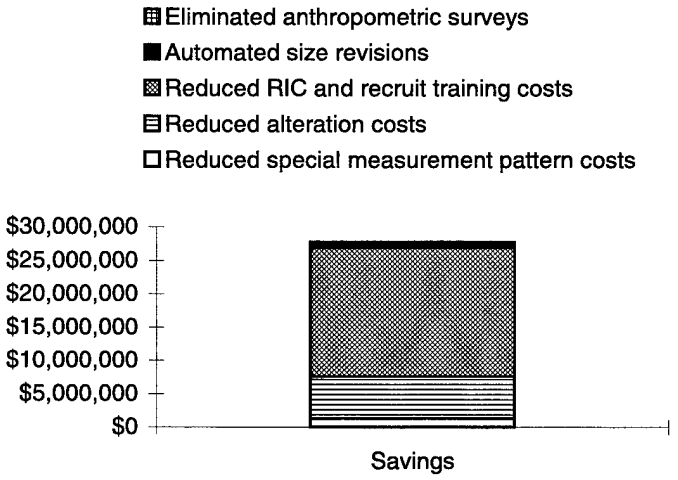
Benefit	FY98	FY99	FY00	FY01	FY02
Elimination of anthropometric surveys	0.10	0.10	0.10	0.10	0.10
Automation of size revisions	0.10	0.10	0.10	0.10	0.10
Reduction in RIC and recruit training costs			6.45	6.45	6.45

Table 2-4. Timing of Measurement and Pattern Generation II Savings (millions of then-year dollars) (Continued)

Benefit	FY98	FY99	FY00	FY01	FY02
Reduction in RIC alteration costs			3.15	3.15	3.15
Reduction in special measurement pattern costs			0.63	0.63	0.63
Total	0.20	0.20	10.43	10.43	10.43

Figure 2-2 shows the total then-year projected savings associated with Measurement and Pattern Generation II.

Figure 2-2. Expected Benefits for Measurement and Pattern Generation II



Chapter 3
Preproduction and Production

The preproduction and production focus group has organized its research into two supertasks, each of which is a collection of individual projects. The preproduction and production supertasks are named Hardware, Automation, and Control and Systems Integration.

HARDWARE, AUTOMATION, AND CONTROL

Description

The Hardware, Automation, and Control supertask will focus on the automation of small parts assembly and sewing operations at defense apparel manufacturers. There are two projects within this supertask. The first project will automate small parts assembly of BDU pocket flaps. A BDU manufacturer, American Apparel, has identified the BDU pocket flap fusing as a prime candidate for this technology. The fusing operation is the first of five operations to make a complete pocket flap subassembly. The fusing operation at American Apparel consists of six operators manually combining BDU flap material with a fusing material and feeding the combined parts in three fusing presses (two operators per machine). This fusing operation is common to a variety of military garments, including shirts, dress uniforms, and coats.

The second project will develop a flexible sewing machine that will compensate for the variation in fabric and reduce the time to change the machine configuration from one material to another. Two defense apparel manufacturers have agreed to installing a prototype machine for evaluation.

Research Costs and Expected Benefits

The cost of development and implementation of the initial flap-fusing equipment will be $606,553. As of 30 Sep 1996, $419,553 had been awarded. The manufacturer will invest an additional $126,000, which is the cost of the three additional flap-fusing units needed to meet production requirements. The manufacturer will also invest $3,000 per flexible sewing machine.

The installation of automated flap-fusing equipment at American Apparel will reduce flap standard assembly hours by 0.0072. This will save about $162,000 per year in operator labor costs at American Apparel. Each flexible sewing machine installed will result in an $8,064 annual savings. There are realistic expectations that up to 16 machines can be put on-line for defense apparel manufacturing.

Table 3-1 shows the costs and savings associated with these benefits.

Table 3-1. Expected Benefits of Hardware, Automation, and Control

Benefit/cost item	Savings/costs
Flap-fusing equipment	
Operation standard hours reduced by 0.0072. Savings equal 0.0072 × $18/hr × 1.25 million units per year.	Savings of $162,000 per year
Manufacturer's cost share of $126,000, amortized over 10 years at 10 percent	Cost of $20,500 per year
Flexible sewing machines will result in $8,064 savings per sewing machine—phased in over years	
FY99: 2 machines ($8,064 savings for each machine, less $3,000 cost).	FY99 savings: $10,128
FY00: 10 machines ($8,064 savings for each machine, less $3,000 cost for 8 new machines).	FY00 savings: $56,640
FY01: 18 machines ($8,064 savings for each machine, less $3,000 cost for 8 new machines).	FY01 savings: $121,152
FY02 and beyond: 18 machines ($8,064 annual savings each).	FY02 and beyond savings: $145,152 per year

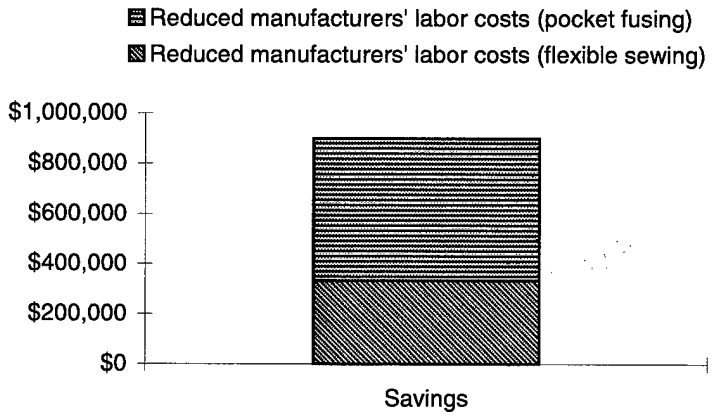
Table 3-2 shows how the Hardware, Automation, and Control savings will accrue over time.

Table 3-2. Timing of Hardware, Automation, and Control Savings (millions of then-year dollars)

Savings	FY99	FY00	FY01	FY02
Reduced manufacturers' labor costs (pocket fusing)	0.14	0.14	0.14	0.14
Reduced manufacturers' labor costs (flexible sewing)	0.01	0.06	0.12	0.15
Total	0.15	0.20	0.26	0.29

Figure 3-1 illustrates the prospective savings subsequent to full implementation of these manufacturing technologies.

Figure 3-1. Expected Benefits from Hardware, Automation, and Control



SYSTEMS INTEGRATION

Description

The objectives of the Systems Integration supertask are to streamline and automate the flow of information between defense apparel firms and the government, and to improve the flow of materials and information at apparel manufacturers. The techniques will be implemented mostly at Haas Tailoring, a manufacturer of dress uniforms (including special measurement uniforms), but will be designed for expansion to other manufacturers.

Systems Integration includes three projects. The first will develop and implement an electronic data interchange (EDI) system between apparel manufacturers and the government. Currently, most defense clothing manufacturers receive paper orders from the government and design, produce, and distribute without computer systems. This project seeks to minimize human intervention in the receipt, use, and transmission of business and technical information. The system will be developed in accordance with the American National Standards Institute X12 series of standards and will include electronic invoices, purchase orders, and advanced ship notices. The system will also lay the foundation for the future transmission of body scan data from RICs to manufacturers (see Measurement and Pattern Generation II).

The second project will evaluate and implement alternative production flow methods in a defense apparel factory. Currently, almost all defense clothing manufacturers use the progressive bundle system, in which large batches of clothing flow through production, causing long throughput times and large work-in-process inventory. Other techniques, such as modular manufacturing, are available and, if properly implemented, can reduce both inventory and throughput time. Implementation is delicate because of the tendency of modular manufacturing to

drive up labor costs. To maintain labor efficiency, the modules, or work cells, have to be carefully designed. Although the initial implementation will target Army dress uniform coats, the solution will be adaptable for other garments.

The third project in the Systems Integration supertask will develop state-of-the-art interactive tutoring and training systems for sewing machine operators. The system will be used for both the training of entry-level sewing machine operators as well as the retraining of skilled employees. The system will permit each trainee to work at his or her own pace and will require minimal assistance from an instructor.

Research Costs and Expected Benefits

The projected ARN costs for Systems Integration total $1,806,489, which includes $1,601,906 for research projects and $204,583 for the apparel manufacturing architecture. As of 30 Sep 1996, $689,054 had been awarded. In addition to ARN funding, Systems Integration will require implementation costs of $10,280 for the EDI system at one manufacturer and one RIC. Annual operating costs subsequent to implementation are estimated at $3,734 for each manufacturer and RIC. Approximate costs for equipment to implement interactive training system-wide is $26,000.

Together, the EDI and production flow projects will allow DLA to reduce its wholesale inventories and will enable manufacturers to reduce their work-in-process and finished goods inventories. The ARN researchers project that direct vendor delivery (DVD) response times will drop to 14 days, eliminating the need for some DLA depot inventory. At the end of the first quarter of FY96, DLA had 172,410 Army dress coats in inventory with a unit value of $100.56 and a total value of about $17.2 million.[1] While the ARN researchers feel they can eliminate depot inventory, they subjectively claim a potential 50 percent reduction for the business case. This would lower the value of DLA inventory by $8.6 million. Furthermore, DLA buys 57 percent of its Army dress coats from this manufacturer. Therefore, the DLA inventory affected by the Systems Integration project at Army RICs would be lower by 57 percent of $8.6 million, or $4.9 million. Given an 18 percent annual inventory holding cost (inclusive of the cost of money), this translates to an $889,416 annual savings.

Work-in-process and finished goods at the manufacturers will be similarly reduced. Currently, the Army dress coat manufacturer produces 2,400 coats per week and has 10,800 coats in process. The EDI and production flow projects will reduce work-in-process by half, to 5,400 coats. Using an average value of $62.85,

[1] The inventory stated represents the sum of men's and women's coats, and the unit value is a weighted average.

this reduction will produce a one-time cash savings of $339,390.[2] The manufacturer's finished goods inventory of dress coats will also be reduced 50 percent, from 4,800 to 2,400, giving a one time savings of $201,120 (finished goods valued at $83.80 per unit).

Employee turnover and the training of replacement workers are significant issues to apparel manufacturers. Presently, typical apparel manufacturers experience a 10 percent turnover. Furthermore, new sewing machine operators are usually inexperienced and must undergo a 12-week training program. On average, two-thirds of new operators drop out of this program after 4 weeks of training. For BDU coats, these statistics translate to an annual dropout cost of $367,356. ARN researchers project they can reduce this cost 25 percent with interactive training tools, which would save manufacturers $91,839 per year. In addition, the interactive tools will reduce training time and improve the output of operators who do complete the program, thereby saving manufacturers an additional $64,610 for BDU production. The combined savings of this project are $156,449 per year. Table 3-3 summarizes the benefits associated with all three Systems Integration projects.

Table 3-3. Expected Benefits of Systems Integration

Benefits	Savings
Reduced DLA depot dress coat inventory of $4.9 million, at 18 percent annual holding cost.	Savings of $889,416 per year, phased in between FY98 and FY00
Reduced manufacturer' s inventory value (taken as one-time savings)	
Dress coat work-in-process of $678,780 reduced by 50 percent.	Savings of $339,390 one time, between FY98 and FY00
Dress coat finished goods inventory of $402,240 reduced by 50 percent.	Savings of $201,120 one time, between FY98 and FY00
Reduced manufacturers' training costs	
Costs due to BDU trainee turnover reduced by 25 percent from $367,356 per year. Annual savings are $91,839.	
Costs due to BDU training time reduced by 10 percent from $646,100 per year. Annual savings are $64,610.	Total annual savings of $156,449 are phased in from FY98 through FY02

[2] To determine the average value of work-in-process inventory, we first adjusted the DLA standard price of $100.56 by the DLA markup of 20 percent to estimate the manufacturer's cost at $83.80. Since materials represent about half of a garment's cost, the average value of work-in-process on the sewing floor is about 75 percent of end item cost, or $62.85.

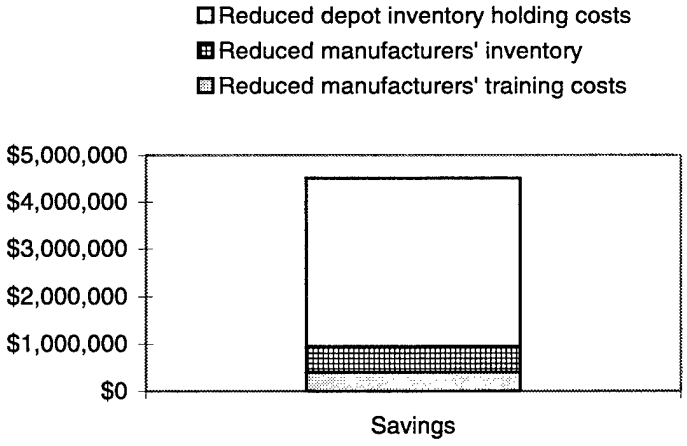
Table 3-4 shows how the Systems Integration savings will accrue over time.

Table 3-4. Timing of Systems Integration Savings (millions of then-year dollars)

Savings	FY98	FY99	FY00	FY01	FY02
Reduced depot inventory holding costs	0.30	0.59	0.89	0.89	0.89
Reduced manufacturer's inventory value	0.18	0.18	0.18		
Reduced manufacturers' training costs	0.01	0.04	0.09	0.12	0.15
Total	0.49	0.81	1.16	1.01	1.04

Figure 3-2 illustrates the expected savings from Systems Integration.

Figure 3-2. Expected Benefits of Systems Integration



Chapter 4
Ordering and Distribution

DESCRIPTION

The Ordering and Distribution supertask seeks to improve retail inventory management and to coordinate the flow of material from manufacturing, through wholesale, to retail. Three projects will demonstrate improved management at, and flow to, the Army's Fort Jackson RIC. These projects will develop software that will enable a RIC to maximize supply satisfaction while operating at minimum inventory levels throughout seasonal cycles.[1] Software will also be developed for manufacturers to use to determine optimum finished goods requirements and to forecast the receipt of delivery orders from the government. These projects will be applied to all hot weather BDU coats ordered by Fort Jackson. The resulting software will be initially implemented at Fort Jackson, but it will also be ready for implementation for no additional cost at the other RICs that use the Army's ACIIP (Army Clothing Initial Issue Point) computer system.

The first project will provide short-term forecasting, order fulfillment, and rough-cut production scheduling. The software will compute new production cutting requirements and will provide these requirements to plant scheduling. The second project will provide analytical methods for optimizing RIC safety stock and operating inventories (cycle stock) and manufacturers' finished goods inventories. The third project will provide mid-term forecasting (up to 1 year) to help smooth the effects of seasonal variations in RIC demand.

Fort Jackson will continue to place requisitions through the ACIIP system for financial management purposes, but the new software will allow them to handle the increasing workloads associated with DVDs and smaller express shipments. Both Fort Jackson and DPSC will be able to control the release of delivery orders and the associated funding application more efficiently than they can today. Also, Fort Jackson will have immediate access to the status of its requisitions, which should reduce the number of duplicate requisitions and cancellations.

In addition to these research projects, the Clemson Apparel Research and California State Polytechnic University demonstration sites have been engaged to operate as "virtual prime vendors" for the U.S. Marine Corps RICs at Parris Island and San Diego. The term virtual prime vendor is derived from the DLA prime vendor

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[1] RIC "demand," determined by the arrival of new recruits, is seasonal. The summer months are busy; the winter months are slow.

program, where the DLA procurement and wholesale inventory management functions are contracted to a private-sector contractor (the "prime vendor"). The demonstration sites will act as "virtual" prime vendors in that they will recommend policies and decisions about what to procure and stock, but the actual procurement and stocking activity will remain with the government. The goals of this effort are a rapid decrease in inventories at the Marine Corps RICs (which currently stand at about 90 days of supply) and to collect data that will enable DLA to apply appropriate terms and conditions to its future prime vendor contracts with private industry.

RESEARCH COSTS AND EXPECTED BENEFITS

The projected ARN costs for the three Ordering and Distribution projects is $1,120,000. As of 30 Sep 1996, none of these funds had been awarded. The virtual prime vendor activity will be conducted as part of the university demonstration sites. Each site, Clemson and California Polytechnic, receives $1 million per year.

The three projects addressing the inventory management of BDU coats issued by Fort Jackson will enable DLA to eliminate its wholesale inventory of those coats. DLA is in the process of eliminating that inventory by implementing DVDs, but with the current inventory management practices at Fort Jackson and ordering practices at DLA, that inventory would be merely transferred either to Fort Jackson or to finished goods at the manufacturer. In regard to the hot weather BDU coat only, Fort Jackson issues represent about 4 percent of DLA's sales of that item. Therefore, 4 percent of DLA's $30.1 million inventory can be eliminated. This equals an inventory reduction of $1.2 million, which, given an 18 percent annual inventory holding rate, represents a yearly savings of $216,405.

These projects will also enable Fort Jackson to reduce its retail inventory of hot weather BDU coats. As of late 1996, Fort Jackson had $295,979, or 69 days of supply, of these items in stock. This inventory will be initially reduced to 18 days of supply, or $77,212. The resulting $218,767 reduction in inventory will produce an annual cash flow savings of $39,378 at an 18 percent inventory holding rate. When the projects have demonstrated a reliable replenishment flow at this lower level of inventory, Fort Jackson's inventory will be further reduced to 8 days of supply, or $34,316. The total inventory reduction at that point (compared to the baseline) will be $261,662, giving an annual savings of $47,099 at the 18 percent inventory holding rate.

The two Marine Corps RICs presently carry 92 days of supply, or $13.5 million. The virtual prime vendor effort will reduce this in three phases, first to 60 days, then to 45 days, and finally to 30 days. At an 18 percent inventory holding rate, these reductions will translate to an annual savings of $845,789, $1,242,742, and $1,639,695, respectively.

Table 4-1 shows the savings associated with these benefits.

Table 4-1. Expected Benefits of Ordering and Distribution

Benefits	Savings
Elimination of DLA depot share of Fort Jackson's hot weather BDU inventory. Inventory reduced by $1,202,247. Inventory holding rate is 18 percent.	Savings of $216,405 per year
Reduced Fort Jackson inventory of hot weather BDUs	
Reduced days of supply from 69 to 18.	Savings of $39,378 in FY99
Reduced days of supply from 18 to 8.	Savings of $47,099 in FY00 and beyond
Reduced Marine Corps RIC inventories	
Reduced days of supply from 92 to 60.	Savings of $845,789 in FY98
Reduced days of supply to 45.	Savings of $1,242,742 in FY99
Reduced days of supply to 30.	Savings of $1,639,695 in FY00 and beyond

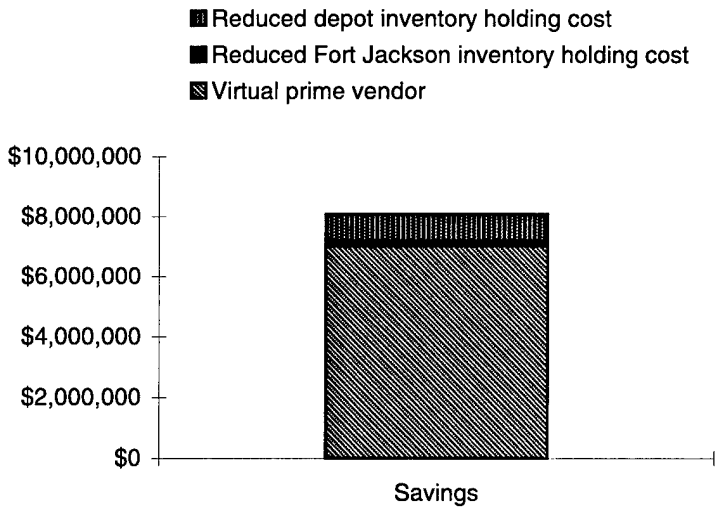
Table 4-2 shows how the Ordering and Distribution savings will accrue over time.

Table 4-2. Timing of Ordering and Distribution Savings (millions of then-year dollars)

Savings	FY98	FY99	FY00	FY01	FY02
Reduced depot inventory holding costs		0.22	0.22	0.22	0.22
Reduced Fort Jackson inventory holding costs		0.04	0.05	0.05	0.05
Reduced Marine Corps RIC inventory holding costs	0.85	1.24	1.64	1.64	1.64
Total	0.85	1.50	1.91	1.91	1.91

Figure 4-1 illustrates the expected savings from Ordering and Distribution.

Figure 4-1. Expected Benefits for Ordering and Distribution



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The Apparel Research Network (ARN) is a consortium, sponsored by the Defense Logistics Agency (DLA), whose purpose is to improve costs, lead-times, and quality in the design, production, and distribution of defense clothing. DLA engaged the Logistics Management Institute to quantitatively describe the defense clothing business in order to support the direction and conduct of ARN research. In Volume I, we present a consolidated statement of costs for that business. We also provide lead-time statistics, focusing on logistics response time, and we discuss quality issues. In Volume II, we perform a cost/benefit analysis of the proposed ARN research program.

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